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ABSTRACT

Recent research suggests that teacher quality is the most important educational input predicting student achievement. Nonetheless, many teachers are less academically skilled than college graduates in other occupations. This study explores characteristics of highly qualified teachers and the connections that exist between these attributes and student learning and achievement. The study reviews research that attempts to correlate teachers' advanced degrees, their pedagogical and content knowledge, types of certification, years of experience, and academic proficiency with student academic growth. The current demand for better teachers coincides with policy and demographic shifts that have made teaching arguably more difficult. The need to improve teacher quality comes at a time when the nation is faced with the task of replacing a generation of teachers nearing retirement age. Exacerbating the need to hire new teachers is the growing number of new students in schools. As enrollment rises, education policy initiatives such as class size reduction have increased the demand for new teachers. The paper discusses teacher skills over time and compared to college educated people in other professions. After examining labor market explanations for teachers' lower proficiency, the paper provides public policy suggestions to increase teacher quality. A primer on statistical methods is appended. (Contains 88 references.) (SM)

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Teacher Quality

and

Student Achievement

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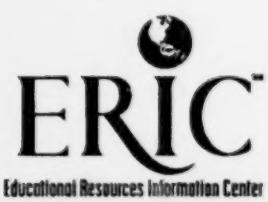

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Overview

The Importance of Teacher Quality

Among professions, the job of teaching has some of the widest economic and social ramifications for our country. The classroom setting is where many students learn social lessons of tolerance, respect, and civic ideals that influence the values and cohesion of our society. Teachers also influence the economic dynamic of our country by imparting skills that translate into innovation and productivity in the workplace. As national economies have become interconnected, and capital flows freely with little geographic constraint, there is an increasing demand for the accumulation of knowledge and skills—known as "human capital"—more so than at any other time in history. Students are now expected not only to master the basics of reading, writing, and arithmetic but also to acquire increasingly valued technical skills that translate into financial success in the labor market. While a high quality education does not guarantee an individual's economic success, it is certainly a key factor in promoting it.

Teachers clearly play an important role in shaping the future of individuals as well as of entire generations. In recent years, new research has demonstrated the dramatic effect that teachers can have on the outcomes of students from all academic and social backgrounds. In fact, studies have shown that teacher quality is the most important educational input predicting student achievement.

Despite the evidence about the importance of teacher quality, many of the individuals in the teacher workforce are, by a variety of measures, less academically skilled than college graduates in other occupations. The concern over teacher quality has been addressed by a number of panels, commissions, and task forces over the last two decades.

> Too many students entering college programs leading to teaching careers are among the lowest achieving graduates of U.S. high schools. (Committee for Economic Development, 1985, p. 36)

> [T]he standards for entering teachers must be raised. (Carnegie Forum on Education and the Economy, 1986, p. 35)
>
> We propose an audacious goal for America's future. Provide every student in America with what should be his or her educational birthright: access to competent, caring, qualified teaching. (National Commission on Teaching and America's Future, 1996, p. 10)

Despite the rhetoric, relatively little has been accomplished to increase the quality of the teacher workforce. While the re-authorization of the national Elementary and Secondary Education Act in 2001 (called the No Child Left Behind Act) requires that states employ only "highly qualified" teachers by the end of the 2005-06 school year, there is no roadmap for how to meet this ambitious and vague goal.

The current demand for better teachers coincides with policy and demographic shifts in the country that have made the job of being a teacher arguably more difficult. The accountability reform movement, designed to ensure that students are learning required skills, places a great deal of the responsibility on their teachers. In fact, the No Child Left Behind Act explicitly requires that states hold schools accountable for student performance on standardized tests. Schools are also becoming more diverse, and in many places, more economically disadvantaged. For instance, the percentage of students who are members of a minority group has risen from 22 percent in 1972 to about 38 percent in 1999, and it is expected to continue rising. This increase accompanies an increase in the number of students who do not speak English as their first language (U.S. Department of Education, 2001),[1] a situation especially prevalent in some areas.[2] Teachers are asked to balance achieving the education goals of the school and teaching these students English language skills.

Staffing Tomorrow's Schools

The need to improve teacher quality and student achievement comes at a time when the nation is faced with the task of replacing a generation of teachers approaching retirement age. Elementary and secondary school teachers are, as a group, older than

workers in other professions: teachers have a median age of 44, whereas the median age of workers in all other professions is 38 (Hussar, 1999). According to the U.S. Department of Education (1999), 25 percent of public school teachers were at least 50 years old in 1993-94 and an additional 42 percent were between 40 and 49. Some forecasts predict that up to half of the nation's public school teachers will retire between 2000 and 2010 (Recruiting New Teachers, 2000). Exacerbating the need to hire new teachers is the growing number of new students in schools. The year 2000 marked the first time in the nation's history that the number of students enrolled in K-12 schools surpassed 50 million. The number of students is expected to continue to increase through the next decade, when the student population is estimated to level off at about 53 million students (U.S. Department of Education, 2000).

At the same time as student enrollment is rising, education policy initiatives such as class size reduction have also increased the demand for new teachers.[3] The combination of these trends means that 2.2 to 2.7 million new teachers will likely be hired over the next decade (Hussar, 1999)—more new teachers hired than any previous decade in U.S. history (Sullivan, 2001).

The confluence of the aging teacher population, the growing student population, and education reforms that require hiring more teachers, presents a challenging policy environment that offers unique opportunities to impact the teacher labor force, students, and the education system, especially in the context of a national education bill calling for states to employ only "highly qualified" teachers.

The questions are, how do we judge who is highly qualified and what types of policies will lead schools to employ more high quality teachers? We explore these issues here, beginning in the next section with our working definition of teacher quality and following that with an argument for why policy-makers should focus on the teacher quality issue. In the fourth section we discuss research connecting various teacher attributes to student learning. Though research does not provide definitive answers to this question, it may serve to guide policy-makers who have to make decisions that shape the teacher workforce.

Our belief, based on the body of research reviewed, is that there is a tenuous relationship between teacher effectiveness and measures such as teacher degree,

experience level, and certification. It is valuable for teachers to have some degrees in some contexts—a mathematics degree when teaching math at the secondary level, for instance—but in general advanced degrees are a poor predictor of teacher quality. Similarly, teacher experience may predict teacher effectiveness, but there is very little evidence of this beyond the first couple of years of teaching. Though measures of teachers' academic proficiency are less commonly used to predict teacher effectiveness, we believe the existing body of research points to these as better predictors of teacher quality.

The above conclusions are not uncontroversial, as education researchers have come to different conclusions based on different studies and sometimes based on reviews of the same studies. There is in fact a great deal of variation in the quality of research assessing the relationship between teacher characteristics and student outcomes. Familiarity with the methodologies used in these studies helps explain why there is so much controversy over what "teacher quality" is, and how policy-makers can influence it. For this reason, we have included a statistical primer as an Appendix to help readers acquaint themselves with these methodologies.

In the fifth section we go on to discuss the skills of the teacher workforce, both over time and compared to college-educated individuals who choose an occupation other than teaching in public schools. Based on the evidence, we conclude that there is a significant reason to be concerned about the academic proficiency of the teacher workforce. Next we discuss some of the labor market explanations for our findings, particularly why disadvantaged students may be more likely to encounter lower quality teachers. Finally, we offer some public policy suggestions to increase the quality of the teacher workforce and some concluding thoughts. In short, we argue that individual education reforms have smaller impacts on the quality of the teacher labor force, and ultimately on student learning, than would a more cohesive approach that involves a reconceptualization of how we think about teacher recruitment and licensure, teacher compensation, and teaching as a career in general.

How to Define Teacher Quality

Teacher quality is an oft-used term, but it is ill-defined. Teacher quality has been understood in a variety of ways over time and by different organizations. Because teachers serve as role models in the classroom, teacher quality has historically been synonymous with personal traits such as high moral character and intellectual curiosity.

Today, teacher quality tends to encompass structured standards developed by two educational organizations: the Interstate New Teacher Assessment and Support Consortium (INTASC) and the National Board for Professional Teaching Standards (NBPTS). INTASC has defined a set of standards for the preparation and licensure of new teachers, while NBPTS has outlined a set of standards for what it believes experienced teachers should know and be able to do.[4] The National Council for the Accreditation of Teacher Education (NCATE) is also commonly viewed as an institution responsible for defining teacher quality, as it has created standards to accredit teacher education programs (National Research Council, 2001).

Though these organizations differ in some respects, the INTASC, NBPTS, and NCATE standards share many common themes. All three argue that teachers should:

> Understand the process through which children learn and develop, and be committed to furthering students' learning.
> Have deep knowledge of the subject they teach and be able to convey this knowledge to students in ways that engages student inquiry.
> Manage and monitor students' learning and reflect on teaching practices, making any needed adjustments to keep all students engaged in the learning process.
> Forge relationships with members of the broader educational community in order to foster students' learning (for a more detailed description of the INTASC, NBPTS, and NCATE standards, see National Research Council, 2001).

Most people are likely to agree with the broad teaching standards presented above, but there is considerable controversy about how teachers can actually achieve and

demonstrate mastery of them. Furthermore, while we tend to think about teacher quality as an immutable characteristic, it is entirely possible that a teacher who is highly effective in one setting is ineffective in another. Some teachers may do well in highly structured environments with explicit standards and accountability measures, while others have teaching styles that flourish in more flexible environments. The skills required to teach honor-track students effectively may be quite different from those necessary to educate students who are struggling in the classroom.

Schools also have different educational philosophies and may therefore want teachers to teach in certain ways (e.g., whole language versus phonics). Although there exists virtually no quantitative research on how teachers who are highly effective in one setting perform in another, one can easily imagine that teacher quality is context specific. For example, while, on average, high school teachers may be more effective if they have a degree in their subject area, there are cases where individual teachers without degrees in their subject may possess deep subject matter knowledge, strong classroom management skills, and an enthusiasm for and an ability to convey curriculum in a way that leads to tremendous learning despite their lack of a degree. Similarly, one can easily imagine cases where the most credentialed teachers lack the ability to connect with students and therefore are ineffective educators.

The bottom line is that highly effective teachers may have a range of attributes and skills, some quite different from one another. In this monograph, we treat *teacher quality* as a teacher's quantifiable ability to produce growth in student achievement, rather than by the individual qualifications or attributes a teacher brings to the classroom, giving consideration to the position that teacher quality should be thought of as specific to the context in which a teacher is teaching. We go on later to discuss which teacher characteristics appear to predict teacher quality.

Why Teacher Quality Matters

There are at least two important reasons why we focus our discussion on the topic of teacher quality. First, new statistical research shows that teachers play a significant role in explaining student achievement. Second, school systems make an extremely large commitment to, and investment in, teachers when they hire them. Teachers, once they have been teaching long enough to receive tenure (typically three years), must be considered by school district officials as close to permanent fixtures in a school system for a variety of contractual and cultural reasons. For these reasons, it is quite important for school districts to make informed choices when hiring teachers.

The Impact of Teachers on Student Learning

Much of the research published since the Coleman Report (Coleman et al., 1966) has confirmed the finding that high quality teachers raise student performance—in fact, it appears that *teachers are the most important education factor influencing student outcomes* (Ferguson, 1998; Goldhaber, 2002; Goldhaber, Brewer, & Anderson, 1999; Hanushek, Kain, & Rivkin, 1999; Wright, Horn, & Sanders, 1997).

Relatively new data sources that link teachers to their students and track them over time have allowed researchers to estimate teacher effects or the *total* impact of teacher quality on students. Each study, though slightly different in methodology, suggests that: (1) teacher quality can have a major impact on students' achievement growth, and (2) there are large differences in teacher quality between teachers within the teacher workforce; and often within school systems and schools.

One dataset that allows for the estimation of teacher effects is the *National Educational Longitudinal Study of 1988* (NELS), a national survey of about 24,000 eighth grade students who were followed into high school and resurveyed in tenth and twelfth grade. Goldhaber, Brewer, and Anderson (1999) used this set of data to estimate both the effects of specific teacher characteristics—such as teacher race and gender, degree and experience levels, and certification status—and overall teacher effects on

student achievement in mathematics in the tenth grade. They found that overall teacher effects accounted for approximately 8.5 percent of the variation in students' tenth grade achievement. Further, they found that a much larger proportion of this 8.5 percent is explained by unobservable teacher-related factors than is explained by observable factors such as teacher degree and experience level. One potential shortcoming of this study, however, is that it does not address the potential that some portion of the effect attributed to teachers actually results from non-random grouping of teachers and students together (e.g., students grouped together by high or low ability level and subsequently assigned to particular teachers).

A study of elementary school students in the state of Texas by Hanushek, Kain, & Rivkin (2002) confirmed that teacher quality is the most important schooling factor explaining student achievement, and that there is significant variation in quality among teachers. Furthermore, because the Texas data include repeated observations of student performance, the researchers could account for the non-random matching of students to teachers and schools. They found that differences in the effects that schools have on students are largely a result of differences in teachers within those schools. They estimated that teacher effects accounted for a minimum of 4 percent of the variation. The effects of teacher quality were found to be much larger than other commonly measured school attributes, such as class size.

Other recent studies, utilizing data linking students and teachers over time, have allowed researchers to assess the long-term effects of teacher quality. Several studies (Sanders & Horn, 1998; Sanders & Rivers, 1996; Wright et al., 1997) of elementary teachers and students used student achievement data collected in Tennessee for the well-known Tennessee Value-Added Assessment System (TVAAS), whereas another (Jordan, Mendro, & Weerasinghe, 1997) used student achievement data from a teacher evaluation system for the Dallas Public Schools (also at the elementary level).[5] These studies also confirmed the aforementioned findings that teacher quality has a greater impact on students than any other schooling factor. Taken together, they tend to suggest that: (1) there is a wide range of effectiveness among teachers, (2) effective teachers are effective with students at diverse achievement levels, and (3) the impact of teacher effects can persist long after students have particular teachers.

The estimated size of the effect of having a highly effective teacher rather than an ineffective one is striking. Using the TVAAS data, researchers grouped teachers into quintiles based on teacher effectiveness (i.e., they placed all the least effective teachers into the lowest of the five quintiles, the teachers who were more effective than these into the next quintile, and so on) and estimated what student gains on standardized exams would be realized in one year for students taught by teachers in the various teacher effectiveness categories. They found that, on average, high achieving students with the most effective teachers gained about 25 percentile points, while high achieving students with the least effective teachers gained only 2 points. The effects of teacher quality were even more dramatic for low achieving students; those in classrooms with the most effective teachers gained over 50 percentile points in their test scores while those with the least effective teachers gained 14 percentile points (Sanders & Rivers, 1996).

While the impact of teachers on student achievement may seem like common sense to some, it contrasts with an earlier school of thought that emphasized curriculum over teacher quality. Variations in student achievement between students who were learning the same curriculum called into question whether there really could be a "teacher proof curriculum." Instead, research has shown is that among all education factors and school resources (e.g., investments in technology, educational materials, class size), teacher quality has the largest impact on student achievement.

Investment in Teachers

Teacher salaries represent roughly 50 percent of educational expenditures in a typical school district (Guthrie & Rothstein, 1999), and unlike investments in other educational interventions such as class size, which can be easily adjusted from one year to the next, teachers become near-permanent investments for the school system once tenured. One reason for this is that union contracts and teacher tenure make it quite costly to fire teachers. For example, the New York State School Board Association released estimates in 1994 (the most recent year for which such information is available) that it costs an average of $177,000 and takes approximately 455 days to fire a teacher, and if the teacher appeals that decision, this cost goes up to $317,000 (McVicar, 1998). Because

of the expenses and difficulty often involved in the procedure, many districts do not fire teachers believed to be poor performers.

The potential permanence of teachers is particularly important given the magnitude of the investment in teacher salaries. We provide an estimate of this investment based on the state salary schedule for teachers in the state of North Carolina.[6] In calculating the cost of employing a teacher for his or her career, we assume that a teacher hired in 2002 has a bachelor's degree, will remain teaching in the state for a 30 years, and will progress up the salary schedule, receiving an additional salary step for each additional year of service. The pay premium associated with one additional year of teaching experience is between $1,000 and $1,500.[7] Including an annual inflation rate of 2 percent, the cost to the school system of the teacher's salary alone for 30 years is over $1.7 million.

This figure of nearly $2 million is actually a conservative estimate because it assumes that salaries will not rise beyond the 2 percent inflation rate and does not reflect higher teacher salaries in districts that choose to pay teachers above the state level or the non-salary costs of the employment of a teacher. Given the anticipated wave of teacher retirements among the aging teaching workforce, and the increasing numbers of students being educated, one might reasonably assume that a tighter teacher labor market in the future will result in higher salaries for teachers.

The teacher investment cost estimate would be higher if it included non-salary state or district costs like professional development, administration costs, and teacher health care and retirement plans. According to an official at North Carolina's Department of Public Instruction, the state of North Carolina, for example, estimates that it spends an additional 7.65 percent of teachers' salaries for Social Security, another 5 percent on retirement and an average of $270 per teacher per year for professional development. Thus, the hiring of a teacher is potentially a major long-term educational investment. This means that it is quite important for school districts to hire the right teachers. In the next section we explore the issue of whether there are teacher attributes that may be used to predict teacher quality. Information about the link between teacher attributes and quality is vitally important to policy-makers who wish to make informed decisions on the issues of hiring and retention.

Teacher Attributes and Teacher Quality Correlations

Attributes such as teacher subject specialty, degree level, certification type, years of teaching experience, or general academic proficiency, measured by standardized test scores (e.g., SAT, ACT, and Praxis®), or the selectivity of the college from which teachers graduated, are often used as proxies for teacher quality.

Much of the debate over which of these attributes are important and how they relate to teacher quality is based on a series of "meta-analyses" of studies relating schooling inputs (class size, teacher degree, etc.) to student outcomes (e.g., test scores). A meta-analysis looks for systematic patterns in results from studies conducted on the same topic, all of which met certain criteria defined by the researchers conducting the meta-analysis.

Surprisingly, some of the meta-analyses on the same teacher (but different school) attributes have reached very different conclusions (Greenwald, Hedges, & Laine, 1996; Hanushek, 1986; 1997; Hedges, Laine, & Greenwald, 1994; Laine, Greenwald, & Hedges, 1995). For example, Hanushek (1986) found that "the results are startlingly consistent in finding no strong evidence that teacher student ratios, teacher education, or teachers' years of experience have an expected positive effect on student achievement" (p. 1162). In contrast, Greenwald et al. (1996) concluded that "variables like teacher academic ability, teacher education, and teacher experience show very strong relations with student achievement" (p. 384). Differences between conclusions among meta-analyses can be explained by the selection of relevant studies and the methodology researchers use to synthesize the various findings. Below we relate our interpretation of what is known about teacher attributes and quality based on these and other studies.

Teacher Degree Level

The results of Hanushek's meta-analysis (1986) on the effect of teachers' education on students are not definitive. Only about 10 percent (11 studies) of the 106 studies that have a measure of teacher's degree level education were statistically

significant, and five of them show that additional teacher education actually has a statistically significant *negative* relationship with student achievement.[9] Greenwald et al.'s (1996) review of similar studies found that teachers with master's degrees had a statistically significant positive effect on student outcomes in 15 percent of the cases reviewed and a statistically significant negative effect in 13 percent of the cases.

Goldhaber and Brewer's (1997a, 1997b) analysis presents a more nuanced portrait of the impact of teacher degrees. They found that a teacher's advanced degree is not generally associated with increased student learning from the eighth to the tenth grade, but having an advanced degree in math and science for math and science teachers does appear to influence students' achievement (Goldhaber & Brewer, 1997b). The same results were not found to be true for teachers of English or history, however. These findings suggest that one potential reason for the fairly inconclusive nature of both of these large reviews on the effect of teacher education (as measured by degree level) on students is the lack of specific information about some teacher variables in the data. A great number of educational production function studies—studies that assess the influence of school factors on student achievement while holding constant student factors—include information on teachers' advanced degrees. The data, however, generally only cover the *level* of the degree and not the *subject* of the degree, although the subject of the degree may impact student achievement in different ways from the degree level. Study results seem to imply, however, that there is little impact from teachers having degrees in subjects different from the subjects they teach.

Teacher Preparation: Pedagogical Versus Content Knowledge

As is the case with degree levels, there is no strong consensus about the value of pedagogical preparation for teachers: the teaching of how to teach. In fact, there is more heated public debate about the merits of traditional teacher training than there is about content-based training for teachers.

Complicating the discussion on pedagogy is the fact that the quality and content of teacher training programs vary greatly. Much of the variation in teacher preparation is due to differing educational philosophies at the institutional level (Wilson, Floden, &

Ferrini-Mundy, 2001). Pedagogical education courses can also vary within a program from generalized to specialized training. Some courses, for instance, focus on context specific teaching methods (for certain school or student types) while others teach subject specific teaching methods. The pedagogical training requirements for teacher certification range anywhere from six to 36 units of pedagogical preparation among the states (NASDTEC, 2001). Few studies directly link how the various types of education courses taken by teachers affect student achievement because of the lack of available data on the topic. Thus, discussions about pedagogical preparation focus instead on secondary measures like the relationship between student achievement and teachers' scores on standardized tests measuring pedagogical knowledge, and the relationship between student achievement and teacher certification status,[10] taken as an indication that the teacher completed some kind of pedagogical training.

Because content knowledge, like pedagogical knowledge, is also not clearly defined or measurable in all content areas, studies often rely on an individual's undergraduate major or coursework as proxies for his/her content preparation, but of course coursework varies greatly across institutions, as does the extent of an individual's mastery of content.

The findings about the effect of teachers' content education on student outcomes seem to be dependent on both subject matter training and the courses they are teaching. As described above, Goldhaber and Brewer (1997a; b) found that students who had teachers with subject-related advanced degrees in math and science performed better than students of teachers without subject training. Research by Monk and King-Rice (1994) on eighth grade students shows, however, that even in subjects where training appears to make a difference (e.g., math), the impact of subject-specific training depends on the context of the classes taught. They found that the number of math courses taken by teachers while in college had an impact on high school students' achievement in math, but that additional teacher coursework beyond that only mattered if the teacher was teaching a more advanced course. Furthermore, they showed that after some point, there were diminishing returns to additional teacher coursework.

Analyzing elementary school students, as Eberts and Stone (1984) did, yields different results. They did not find a positive relationship between the number of math

courses taken by teachers and their fourth grade students' achievement in math. Subject matter training, proxied by advanced degrees, made a difference to student outcomes in some contexts but not all.

There are too few studies that are specific enough to conclude firmly that non-subject-specific degrees are not correlated with student outcomes, but at the very least it seems reasonable to conclude that teachers having advanced degrees in specific subjects can have an impact on student learning in those subjects in certain settings.

Teacher Licensure

Traditionally, states have regulated who may become a teacher through their licensure policies, whose the primary purpose is to assure the public that individuals in the teaching profession have at least a minimal standard of teaching competence such that they are qualified to begin practicing in the profession. Licensing policies typically require that prospective teachers complete a standard set of college level courses in pedagogy or in the subject they wish to teach, and that they pass one or more standardized tests.

The public policy debate over the appropriate role of the state in regulating the teacher labor market has grown increasingly intense, likely due in part to the pressure of a tighter teacher labor market in many states. As a result, many states are now permitting schools to employ non-traditionally licensed teachers. Some believe that alternative route teachers (those who receive an alternative license or certification) are generally unprepared to teach, while others feel that alternative routes represent a potentially important way to attract high quality individuals into the teaching profession who would not otherwise become teachers.

One review by Evertson, Hawley, and Zlotnik (1985) found that 11 of 13 studies judged fully licensed teachers to be more effective than those who had not completed all the requirements for full licensure.[11] Only four of these studies, however, measured actual student achievement and most of these studies predated the use of value-added methodology (described in the Appendix). A more recent study by Goldhaber and Brewer (2000) used a value-added methodology to compare the achievement levels of high

school students taught by teachers with different types of licensure. They found that students taught by fully licensed teachers tended to have higher *levels* of performance in math and science on average, but when measuring *growth*, there were few differences in student achievement between students with teachers who held standard state certification and those with emergency certification in subjects,[12] illustrating the importance of measuring *student achievement gains* instead of *levels*.

A more recent review of a host (about 150) of studies on teacher certification by the Abell Foundation (Walsh, 2001) concluded that the research on the teacher attributes correlated with teacher quality "does not show that certified teachers are more effective teachers than uncertified teachers" (p. iv). This review touched off significant back and forth debate between those supporting and opposing the Abell report's findings and conclusions over which studies are of a high enough quality to inform the debate over teacher licensure, as well as over the interpretation of the findings from the various studies included in the report.[13]

The fact that the findings of research on teacher licensure is mixed is not terribly surprising. As we describe below, there is great variation among the states in the specific requirements to enter teaching through both traditional and alternative routes. Because of these differences, and because alternative licensure programs are both new and relatively small, there are few rigorous studies on the relationship between teacher preparation requirements and student outcomes.[14] Perhaps equally important, there is virtually no evidence on the possible impact of state requirements on the number or type of individuals who opt to pursue a career in teaching. For these reasons, we do not believe there is a strong enough research base from which to draw definitive policy conclusions about the value of regulation of the teacher labor market by the state.

Teacher Years of Experience

There is a wide range of findings on the relationship between teacher years of experience and student outcomes. Hanushek (1986) reviewed 109 previous studies on the estimated effects of teacher experience and found that fewer than half of them showed that teacher experience had any statistically significant effect on student achievement.

Among the 40 studies that found teacher experience to have a statistically significant effect, seven found that additional years of experience actually had a negative impact on student achievement, while the remaining 33 found a significant positive effect.

The Hedges et al. (1994), Laine et al. (1995), and Greenwald et al. (1996) reviews show a stronger positive relationship between teacher experience and student outcomes. These authors suggest that Hanushek's method of simply tallying the number of statistically significant positive and negative effects ignores the patterns of the studies' results. They argue that if there truly is no relationship between teacher factors like degree level and years of experience, then roughly half of all studies would find positive effects and half negative, and only about 5 percent of studies would report experience to have a statistically significant impact on student outcomes. But, in the Greenwald et al. (1996) review, for instance, teacher experience was found to have a statistically significant positive effect in 29 percent of the cases reviewed and a statistically significant negative effect on student achievement in only 3 percent of cases. Thus, rather than a balanced distribution of positive and negative results, the studies in this meta-analysis tilt in the direction of suggesting that experience actually is a predictor of teacher quality.

Though the Hedges et al. (1994), Laine et al. (1995), and Greenwald et al. (1996) studies argue that the pattern of positive and negative findings do provide fairly conclusive evidence, the findings are not overwhelming; the effects for both degree and experience levels were only statistically significant in about 30 percent of the estimates in each case. One might reasonably infer then that the magnitude of the experience effect, should it exist, is not terribly large. In addition, it is plausible that a positive finding on experience results not from a causal relationship between experience and student outcomes but from the tendency of more senior teachers to select higher-level classes with higher achieving students (Hanushek, 1986). It is also true, however, that these meta-analyses are not specific about the grade levels, subject taught, or backgrounds of the students being studied. Thus, it is not possible to get a broad consensus from the literature about whether teacher characteristics, such as experience, tend to matter more or less in different contexts. We argue below that teacher experience has probably been

measured in such a way as to make it difficult to discern differences in teacher quality by experience level.

One problem with most educational production studies on years of teaching experience is that they treat every year of teaching experience the same, even though, intuitively, there may be substantial differences between, for instance, the impact of experience gained in the first few years of teaching and experience gained between the twenty-fifth to the twenty-sixth year of teaching. Indeed, some more nuanced educational productivity studies focusing on teacher experience have found that not every year of teacher experience has the same impact on teacher effectiveness as every other year. As an example, a study by Murnane (1975) suggests that the typical teaching learning curve is steep and rises upwards until a peak is reached in a teacher's first couple of years (estimated to be year two for reading and year three for math) and then decreases slightly or plateaus after that for the remainder of his or her teaching career. This pattern is not based solely on teacher performance but may also be attributed to the attrition of high performing teachers after about three years in the profession.

Although there is no consensus on this shape of the teacher learning curve[15] and the cutoff of the crucial years of experience, researchers tend to agree that the direct benefits of additional years of teacher experience tend to be in the first five or so years in the classroom and level off after that (Darling-Hammond, 2000). In fact, recent studies that do allow for a non-linear relationship between teacher experience and student achievement found convincing evidence that experience in the classroom does matter more early on in a teacher's career (Kain, 1995; Hanushek et al., 2002).

Teachers' Academic Proficiency

Although teacher degree level, experience, and certification status are the most widely studied teacher attributes, Goldhaber et al. (1999) show that these teacher characteristics explain only about 3 percent of the total teacher effect on student achievement. Researchers, however, have also focused on the relationship between student outcomes and measures of teachers' general academic proficiency, proxied by measures such as performance on tests of verbal ability, teacher licensure or college

entrance exams, and the selectivity of the undergraduate institutions attended by teachers. These quantifiable measures may serve as a catch-all for a variety of less tangible teacher attributes such as intelligence and motivation.

While there are fewer studies predicting student achievement that include measures of teacher academic proficiency than those that include degree and experience levels, the existing research is consistent in showing a positive relationship between the two.

Several aggregate-level studies (Ferguson, 1991; Ferguson & Ladd, 1996; Strauss & Sawyer, 1986; Strauss & Vogt, 2001) at the elementary level found a relationship between teachers' academic proficiency and student achievement. Ehrenberg and Brewer (1995) reanalyzed the Equality of Educational Opportunity data and found a statistically significant relationship between teacher performance on a short test of verbal ability and student achievement gains. But the fact that all these studies were done at the aggregate level (school or school district level) as opposed to teacher or student level, casts some doubt on them. Again, there are measurement issues and issues of causality. As a result, it is unclear whether higher-scoring teachers lead to higher-scoring students or whether affluent districts, which tend to have higher-achieving students, tend to hire teachers with higher scores.

Studies at the individual student level show mixed findings about the relationship between teachers' academic proficiency and student achievement. Summers and Wolfe (1975), using the Gourman rating as a measure of college selectivity, found that teachers who attended more selective undergraduate colleges are more effective. A more recent paper by Ehrenberg and Brewer (1994), in which they judged the selectivity of undergraduate institutions based on Barron's college ratings, confirmed the finding that students learn more from teachers who attended more selective undergraduate institutions. Greenwald et al. (1996) found a total of only nine studies that analyzed the effects of teacher academic proficiency (they use the term "academic ability") on student achievement. However, positive relationships between teachers' academic proficiency and student achievement were found in the overwhelming majority of these studies. Thus, taken as a whole, the above literature suggests that *measures of teacher academic proficiency represent one of the best predictors of teacher quality.*

Skills of Teachers Over Time

Assessment of educational productivity and the quality of the teacher labor market as a whole often involves a comparison between teachers today and those who were teaching in years past. This comparison is an important one because, as discussed in the next section, some significant changes that have occurred in the labor market may have impacted on the quality of individuals who opt for a career as a teacher.

As far as we are aware, there are no studies that directly address the question of whether the quality of the teacher workforce has changed over time as measured by student learning gains. There are, however, several studies that examine changes over time in the characteristics of individuals who opt to be teachers, and they tend to suggest that the quality of teachers has declined.

Research on the standardized test scores of cohorts of white females shows quite clearly that older white female teachers (who presumably entered the workforce earlier) tend to score higher on IQ and other standardized tests (such as the Armed Forces Qualification Test) than younger white female teachers. For example, 45-50 percent of white females born in the 1940s who entered the teaching profession scored above the eightieth percentile, compared with only about 15 percent of those born in the mid-1960s (Bacolod, 2001).

In a study of changes in the teacher workforce in New York State, Lankford, Loeb, and Wyckoff (2001) found a similar pattern of declining scores for teachers from 1985 to 2000. In 1985, less than 10 percent of teachers failed either of the two commonly used teaching entrance exams (the NTE General Knowledge and the NYSTCE exams) in New York, whereas the failure rate was over 20 percent for teachers in 1999.[16]

One could argue that if a different criterion, such as an advanced degree, is used to measure academic skills, then teacher skills have actually increased over time. Since the mid-1960s, the percentage of teachers receiving a master's degree or higher has increased from roughly 30 percent to over 40 percent in the mid-1990s.[17] These findings,

however, may be somewhat misleading. While the percentage of teachers earning advanced degrees has risen, there has been a precipitous shift away from teachers receiving master's degrees and/or Ph.D. and Ed.D. degrees from "top tier" public and private research universities, based on Carnegie classifications (Turner, 1998). The share of teachers receiving their master's degrees from both public and private research universities fell from about 30 percent in 1966 to less than 20 percent in 1995.

Skills of Teachers Compared with Skills of Other Professionals

Another way to look at the skill level of teachers is to compare various measures of academic proficiency and preparation between the individuals likely to go into teaching and those likely to enter other professions. Using a variety of measures of academic proficiency, we see that the teaching profession as a whole seems to attract less academically proficient individuals than other occupations (see Goldhaber & Liu, 2003, for a full discussion of this issue). As an example, high school seniors who indicated an intention to major in education had mean verbal SAT scores of 409 out of 600 in 1993-4 compared with scores of 438 for those intending to go to college and major in the social sciences, 452 for the arts and humanities, and 500 for high school students intending to study the physical sciences in college (U.S. Department of Education, 1997b).

Empirical evidence has painted a similar picture for those who indicate inclinations to go into teaching while in college. The 2001 *Condition of Education* report by the U.S. Department of Education indicates that elementary school education majors tend to have the lowest college entrance exam (the SAT or ACT) scores among all college majors. As is shown on Table 1, which reports the quartile of the test distribution that individuals with different majors fall into, a lower percentage of education majors were in the top quartile of the SAT or ACT distribution than all other college majors.

Also, while in college, more education majors report taking remedial math and English courses than non-education majors (U.S. Department of Education, 1996). Fifteen percent of education majors report taking at least one remedial math course as compared with 12 percent of non-education majors. The corresponding figures for remedial English are 13 and 7 percent.

Table 1. College Entrance Exam Scores by Major

College Major	Bottom Quartile	Middle Half	Top Quartile
Education	28.1	57.8	14.1
Business/Management	25.3	56.9	17.8
Humanities	20.6	48.0	31.4
Mathematics/Computer/ Natural Sciences	13.0	49.8	37.3
Social Sciences	22.7	51.7	25.7
Other	31.9	50.9	17.2

The difference in academic proficiency is also observed in college students planning to obtain an advanced degree. For example, the mean Graduate Record Exam (GRE) scores for those intending to do graduate studies in education were 477 in 1987-88, compared with mean scores of 529 for those intending to do graduate studies in the social sciences, 541 for business, and 685 for engineering (U.S. Department of Education, 1997b). Those who actually became teachers after college still had lower scores on their college entrance exams than did individuals who entered other occupations. Goldhaber and Liu (2003) found that among a group of recent college graduates (those who graduated in 1992-93), public sector teachers had an average SAT score of 946 whereas the average score for all non-teachers was 1003. Research also shows that the teachers who quit the profession tend to be more academically proficient than those who remain in it (Hanushek & Pace, 1995; Murnane et al., 1991).

The above findings would not be troubling were there no relationship between academic proficiency and student outcomes, but as we described above, measures of teachers' academic proficiency appear to be among the best predictors of teacher quality.[18] So what explains these observed trends? Part of the explanation may lie in the

way that the teacher labor market tends to function, an issue that is discussed in the next section.

Teacher Supply and Demand: The Effect of the Labor Market

We argue that the quality of the current teacher workforce may be related to a number of labor market issues. First, more opportunities in other occupations have opened up for working women and minorities who once composed the majority of the teacher workforce when other professions discriminated against these groups. There are also issues related to the teacher pay structure that may make it more difficult to attract individuals with stronger academic backgrounds or specialized skills.

There have always been significant differences in the opportunity costs for individuals with different attributes (e.g., college major, GPA) to enter and remain in the teaching profession, as opposed to other professions, because the pay structure of teaching does not reward many skills. Research shows that measures of academic proficiency are generally correlated with higher wages in most professions (Goldhaber & Liu, 2003), but the salary structure in teaching may not allow for this.

The economic payoff to attending a highly competitive college, for instance, has grown considerably in recent years. The estimated pay premium associated with attending a top tier private college (as ranked by *Barron's*) as compared with attending a bottom tier public college grew from 9 percent in 1972 to approximately 39 percent in 1992 (Brewer, Eide, & Ehrenberg, 1999). The fact that individuals who attended more selective colleges tend to earn higher salaries than those who attended less selective institutions suggests that, within each school district, the former group is likely have to sacrifice more in terms of salary to become a teacher than the latter group (in other words, they face a higher opportunity cost for being in the teacher workforce).

Teacher salaries also typically do not differ by subject specialization, whereas earnings in the labor market as a whole typically do. In particular, the U.S. economy appears increasingly to reward the acquisition of technical skills, such as the completion of degrees in math and science (Murnane, Willett, & Levy, 1995). Goldhaber and Liu (2003) showed that the salary differential between technical and non-technical majors in the non-teacher labor market was $5,854, whereas the differential for public teachers was

$211. Thus, public schools face stiff salary competition to recruit individuals who have those skills.

The labor market clearly also plays a role in explaining the observed patterns of supply and demand. For instance, despite the numerous statistics and stories about the current or anticipated severe teacher shortage, which is nothing short of a national crisis, a more accurate characterization is that it is difficult to find high quality teachers to fill certain positions in certain school systems and schools. In fact, in contrast to the conventional wisdom about a teacher shortage, there are some states where, in recent years, more teachers were licensed in a particular subject than there were teaching positions available (Strauss, 1999). Some teaching jobs will be more attractive than others depending on salary and a host of non-monetary factors that shape the work environment and the classroom experience. There is in fact a significant variation in teaching supply for schools within the same metropolitan area (National Commission on Teaching and America's Future, 1996), and the variation in teacher supply is actually higher within than between states (Ingersoll, 2001). At least part of the explanation for these findings is the widespread use of the single salary schedule as a compensation structure. Teacher salaries are not competitively determined so they tend not to be differentiated according to differences in teachers' academic skills or subject matter specialization, or the degree of difficulty of the job. In the absence of pay differentials that mediate demand and supply conditions for particular types of teachers, and differentials to compensate for non-monetary job characteristics (e.g., the degree of difficulty of the job), demand and supply conditions result in a sorting by teachers between and within school districts and schools based on both salary and non-pecuniary job conditions (see Goldhaber & Eide, 2002, for a comprehensive treatment of the relationship between teacher compensation and teacher quality).

Both salaries and teaching conditions vary by school district. Even within school districts there is significant variation from school to school in working conditions, such as the quality of school buildings and educational materials and the academic proficiency of students (Loeb & Page, 2000). Empirical evidence shows quite clearly that those teachers with the best job market opportunities tend to migrate to positions in schools and districts with both higher salaries and high socioeconomic and high achieving students when these

positions open (Lankford, Wykoff, & Papa, 2000; Hanushek et al., 2002). In fact, while salaries influenced teacher movements from district to district, the impact of student demographics and achievement levels on teacher decisions was found to be larger (Hanushek et al., 2002).

As a result, the most disadvantaged students tend to be taught by less credentialed and experienced teachers. Studies have found that low-income schools are more likely to be staffed by fewer tenured teachers, more uncertified teachers, more teachers with no more than a bachelor's degree, and more teachers who have failed tests of basic skills (Loeb, 2001). Schools with larger numbers of low-income students are also more likely to be staffed by teachers who have graduated from less selective colleges (Ballou, 1996; Wayne & Youngs, 2001). Finally, out-of-field teaching is also more prevalent in low-income schools, suggesting that these schools have a more difficult time matching qualified applicants who have the appropriate skill sets with the available positions. Among schools with less than 20 percent of the students receiving free lunch, 28 percent of math teachers are out-of-field teachers, compared to 40 percent for schools with more than 49 percent of the students receiving free lunch. Similar trends exist for science, English, and social studies teachers teaching out-of-field (Ingersoll, 1998). Clearly, teacher sorting between schools and school districts is related to working conditions, and often to the student population.

The quality of teachers in every school is important, however, and the evidence provided in this section suggests that teacher quality problems tend to be concentrated in schools serving predominantly disadvantaged (lower achieving, higher poverty, etc.) students. This is true whether the proxy for quality consists of characteristics such as degree and experience level or teachers' academic proficiency (Lankford et al., 2001).

Thus, in the next section, we explore the public policy implications of the research findings presented and provide suggestions for improving teacher quality, paying particular attention to policies designed to address teacher quality issues affecting disadvantaged students.

Moving Towards Solutions to the Teacher Quality Problem

Upgrading the composition of the teacher workforce is no small task. Significant improvement in teacher quality as a whole, and in specific student populations, are only likely to occur with a number of simultaneous reforms in the way that states and localities currently operate. Effective reforms would involve the interaction of various licensure programs, teacher compensation policies, teacher recruitment efforts, the teacher selection process, and changes in the concept of teaching as a profession. A useful place to begin is to think about which individuals should be eligible to enter the teacher workforce.

Teacher Licensure

Traditional teacher licensure is controlled by the state and it allows states to set standards for the quality of individuals who make up the applicant pool. This procedure may be useful to local school districts when hiring teachers in that they view licensed teachers as meeting some quality standard. State control of licensure also may prevent political or other pressures, such as nepotism, on hiring decisions that do not benefit students.

It is common to associate teacher licensure with mastery of the teaching skill set, as can often be witnessed in popular press today.[19] Despite this association, the specific licensure requirements for college majors, coursework, teacher assessments, and student teaching experience vary from state to state. For instance, 12 states require teachers to have majored in education while 12 other states require non-education degrees (NASDTEC, 2001). The number of required units in pedagogy also varies significantly.[20] Thirty-four states require that teachers take a subject matter exam to obtain a teaching certificate, only 13 states require teachers to take a general knowledge exam, and 15 states require that teacher candidates have some previous teaching performance assessed and submitted to state or school officials. Two states do not require teacher candidates to

have any student teaching experience before they can obtain a teacher's license (NASDTEC, 2001).

In addition to traditional teacher licensure programs, non-traditional licensure programs—known as alternative licensure—have grown in popularity in the face of a select teacher shortage and a concern about the quality of the teacher labor market. For instance, in 1986, only 18 states accepted teachers who were prepared to teach by alternative sources. In 2000, 44 states plus the District of Columbia accepted teachers outside the traditional licensure process. Many advocate alternative licensure programs as a way to entice more individuals into the profession who otherwise might have judged the time and costs of teacher preparation programs as too high when compared to their other career opportunities. Others also support alternative teacher licensure because they say that judgments about teacher qualifications and quality should be made at the local level where officials are in a better, more informed position to do so based on an applicant's qualifications and an individual school's needs, rather than allowing teacher preparation programs to define what qualities to require of teacher candidates.

Opponents argue that allowing individuals to enter teaching without conventional training leads to a downgrading of teaching as a profession. On its web site, the National Commission on Teaching and America's Future (NCTAF) voiced concern over looser certification standards for teachers in the context of higher accountability standards for schools: "If students are to achieve high standards, we can expect no less from their teachers and other educators."

The lack of clear evidence on the efficacy of teacher licensure suggests that policy-makers should continue experiments, such as Teach for America, that allow individuals to enter the teaching profession through alternative routes. Any expansion of the teacher applicant pool is likely to be beneficial, particularly for schools serving disadvantaged students, because, as noted above, they already have difficulty staffing their schools.

While we advocate continued experimentation with alternative route programs, we do not believe that states ought to stop regulating the teacher labor market altogether. The costs of making poor hiring decisions are potentially very high for both students and society. What is needed is a better sense of the costs and benefits of different educational

policies and different teacher attributes so that states can know the teacher requirements that may lead to better student outcomes. This requires a greater commitment from states to study the impacts of their specific licensure policies.

While variations in states' licensure policies, both traditional and alternative, present opportunities for research into which, if any, requirements for prospective teachers ultimately enhance the quality of the teacher workforce, they also inhibit to some degree the value of a teaching license, since a license granted in one state is not fully portable to another. It is likely that this fact creates frictions in the teacher labor market, meaning that at least some potential teachers who move from one state to another opt not to teach in their new location, either because they find it too onerous to determine whether they meet the requirements in their new state or because they do not wish to do what is necessary to meet a different set of requirements.[21]

This problem is addressed by many states, at least to some degree, through agreements to license teachers automatically who have satisfied another states' requirements. This practice, however, is far from universal and it is not always clear (in fact, it is often not at all clear) specifically what is required of prospective applicants who have satisfied licensure requirements in one state but wish to teach in another. Thus, to ensure a more cohesive system of high teacher standards that have requirements relevant to student outcomes, we recommend that states should consider greater coordination to ensure that someone teaching or licensed to teach in one state is eligible to teach in another. At a minimum it is important that potential teachers be able to easily obtain information about the specific requirements to teach in a particular state. This information is sometimes only available in Byzantine ways. Technology could greatly improve this situation if used appropriately, however. It would be easy, for instance, to create and update a web-based dataset that allows someone teaching in California who wishes to teach in New Hampshire to punch in those two states to find out what he or she would need to do make such a move and be eligible to teach.

Teacher Compensation and the Applicant Pool

Aside from regulatory changes in the teacher licensure system, any meaningful expansion of the teacher applicant pool is likely to occur only with increases in, and perhaps changes in the structure of, teacher compensation. There are many different ways to increase compensation levels. Some advocate across-the-board salary increases. Significant across-the-board salary increases, however, are likely to be so costly as to be politically unfeasible. As a back of the envelope calculation, current per pupil expenditures would have to increase from approximately $6,500 to nearly $8,800 or $9,400 if teachers' salaries were made more comparable with those received by full professors or engineers. This represents a range of a 35-45 percent increase in teachers' salaries, which seems unlikely.[22]

Furthermore, even if politically feasible, across-the-board increases may not have much of an immediate impact on the quality of the teacher workforce. The reason is that when salaries rise, current teachers have less of an incentive to retire, and may choose to remain in the workforce, closing a position that would have otherwise gone to a qualified younger teacher (Ballou, 1996). This possibility may help explain the fact that there are few studies that find a direct link between teacher salaries and student outcomes (Grissmer, Flanagan, Kawata, & Williamson, 2000; Hanushek, 1986; 1997).

Though there is no proven research base to establish a basis for targeted salary increases, we would argue that this type of increase represents a promising, and more cost-effective, method to increase teacher quality. In particular, states and districts might consider rewarding teachers who agree to take challenging jobs (e.g., those in high poverty schools). Districts might also consider salary increases that are *targeted* to those teachers who are most difficult to recruit (e.g., math, science, special education subject specialists). Finally, we believe it is worth experimenting with salary structures very different from the single salary schedule, such as: school-based bonuses, competency-based pay, merit pay, and career ladders.

The Paramount Role of Local School Districts

While state licensure requirements help shape the potential pool of applicants in all districts, districts play an important role in shaping the quality of their own applicant pool and, ultimately, their workforce through their recruitment and selection practices. Several recent studies suggest that school districts do not generally cast a wide net in searching for applicants, relying instead on the local labor market. Strauss et al. (1998), for instance, found that only 25 percent of Pennsylvania school districts advertised open teaching positions outside of the state. Most school districts in Pennsylvania did not advertise or seek teacher candidates outside of their local labor markets and, on average, 60 percent of newly-hired school teachers came from teacher preparation institutions no more than 70 miles away from the hiring school district. The employment of local teachers in schools may also be a product of teacher preferences to teach in schools close to their hometowns. Boyd, Lankford, Loeb, and Wyckoff (2002) found teachers to be twice as likely to work at a school within five miles of their hometown (more precisely, where they graduated from high school) than working at one within 20 miles of their hometown. Of New York teachers, 82 percent took jobs teaching at schools that were within 40 miles of their hometown district. These examples highlight the prevalence of regional labor markets in the teaching profession.

The practice of hiring teachers who grew up close to the schools could be a benefit if the schools found a sufficient number of high quality teachers from their local labor markets, because they could save recruitment costs and use the savings for other education programs. But these local labor markets are often not sufficient and, given the importance of teacher quality, it is not hard to imagine that the benefits of casting a wide net exceed the costs. School districts can expand their recruitment efforts by using technology to search for applicants, both in local labor markets and a larger geographic area. Many school systems use the internet to provide potential teacher applicants with information about the benefits of teaching in their districts. It is easy to imagine an expansion of the use of the web in terms of clearinghouses that advertise across states, or partnerships with colleges or private sector national job search companies (e.g.,

Monster.com) to attract more teacher applicants in order to find the best candidate for a specific position.

Increasing the size of the teacher applicant pool is one step that local districts can take to ensure that they have the luxury of choice when hiring, but the hiring decision itself is also key to determining the quality of the teacher workforce. Although there is little quantitative evidence about the specific processes used by districts when hiring teachers, there is some evidence that school personnel may not be doing a good job of selecting among teacher applicants. Ballou (1996) conducted research on the likelihood that teachers with various attributes are hired, and found that districts do not appear to value measures of academic proficiency. For example, teacher applicants who attended "above average" colleges were actually significantly less likely to be hired than were applicants who had attended "below average colleges." Furthermore, teacher attributes such as undergraduate GPA and subject specialties have only a small effect on an applicant's probability of being hired. For example, in 1993-94, only 30.8 percent of districts reported that they require hired teachers to have passed the National Teachers Exam. Instead it seems that districts rely on the presence of traditional teacher licensure as a primary means of screening among applicants and look to graduation from a state-approved teacher education program as a secondary means of winnowing out the applicant field (U.S. Department of Education, 1997a).[23]

A survey conducted in 1996 of 97 elementary and secondary school principals asked them to rank 12 criteria used in the selection of teachers in order of importance when making hiring decisions. The following factors were the results in order (Cain-Caston, 1999).

(1) Evaluation of student teaching performance by public school supervisor.
(2) Effective use of oral and written English.
(3) Personal appearance (neat, clean, exhibits good taste in dress).
(4) Grade point average in college major area.
(5) Scores on the National Teachers Examination.
(6) Evaluation by college instructors in major subject area.
(7) Evaluation by college instructors in professional education courses.

(8) Evaluation of student teaching performance by college supervisor.

(9) Accumulative grade point average.

(10) Environment in which applicant was reared (rural, urban, low income, middle class, etc.).

The quality of teachers hired could be enhanced through improvements in the screening and interview processes associated with hiring. Anecdotal evidence suggests that teacher applicants typically do not go through an intensive screening process prior to being hired. They are, for instance, rarely asked to teach sample lessons or to document in detail their teaching practices. Requiring applicants to demonstrate their teaching abilities in one way or another would provide administrators responsible for selecting the best teacher with important knowledge about the applicants' skills, teaching styles, and knowledge content. In addition, school districts should play on active role in understanding findings from studies on various teacher attributes and student achievement so they know what teacher qualities might maximize student learning.

Reconceptualization of a Teaching Career

Realistically, districts are only able to make the changes suggested above to expand the quality of teachers in the applicant pool when they have sufficient resources at their disposal. Many local districts that suffer the most from poor teacher quality are the same districts that have little room in their budgets to allocate resources to enhance recruiting and hiring processes. How then can these districts improve the quality of their teaching staff?

An alternative strategy to address teacher quality concerns is to change expectations of time and placement in a specific teaching position. The current perception of the teaching professional is that of the lifetime teacher working in the same school or district for the duration of his or her labor market participation. As the number of careers that individuals have over their lifetime is increasing, the seemingly fixed duration of teacher employment may discourage potential applicants who are interested in teaching

for only a few years. This is in fact part of the impetus for the creation of alternative certification programs.

Thus, we would argue that school districts might also consider other innovative employment options. For instance, multiple districts might band together to share expert level teachers. Currently, many large urban school districts are already shifting teachers between schools as the need for them rises and falls at different locations. This practice could be extended to districts so that teachers would be able to staff multiple districts at the same time rather than having the limited option of leaving the profession. This type of employment might provide individuals with greater compensation and allow some districts access to specialized employees that they might otherwise not be able to afford to hire on their own.

Conclusion

While empirical research clearly shows that teachers have huge impacts on students, there appears to be no consistent, easily discernable traits associated with teacher effectiveness. In our review of studies on teacher characteristics and education production functions, we find evidence suggesting that measures of teacher academic skills are better predictors of teacher effectiveness than are other measures, such as degree and experience levels. Unfortunately, the teacher workforce appears, on average, to be less academically proficient in comparison with other college graduates. Furthermore, regardless of the measure used to assess quality, we find that teachers tend to be inequitably distributed across students, with poor students far less likely to have access to high quality teachers than their more affluent peers. Thus, as a nation we may not be attracting as many academically skilled individuals into the teacher workforce as we would like, and many of the most needy students are being particularly ill-served. Solutions to these problems are not clear-cut. But we would argue that progress may be made through a series of reforms that involve a reconceptualization of how we think about teacher licensure, recruitment, compensation, and ultimately a teaching career.

Notes

[1] Twenty-five percent of Hispanic students report that they speak mostly Spanish in their homes.

[2] For example, California reports that 1.4 million students, nearly one-fourth of the student population in the state, receive LEP services while Texas reports that half a million students in the state receive LEP services for limited English proficiency students (U.S. Department of Education, 2001).

[3] For example, since California adopted its mandatory class size reduction policy in 1996, the state hired an additional 23,500 teachers, increasing the overall teaching workforce by 38 percent in the first two years of the legislation (Stecher & Bohrnstedt, 2000).

[4] See www.nbpts.org for more information.

[5] Both studies use "mixed-model" methodology. For details about both the TVAAS methodology and the methodology used in Dallas, see Millman, 1997.

[6] The single salary schedule, which is used by approximately 95 percent of public schools, is a compensation structure whereby teachers' salaries are typically determined solely by teachers' education level and years of experience (Odden & Kelley, 1997).

[7] Pay premiums for further education are approximately 11 percent for master's degrees, 14 percent for education specialists, and 17 percent for doctorates (Goldhaber, 2001).

[8] The Praxis exams are designed specifically to assess beginning teachers. There are three different versions of this test: Praxis I is an assessment of academic skills to be taken by individuals entering teaching training programs, Praxis II is a subject assessment to gain licensure to enter the profession, and Praxis III is a classroom performance assessment for first year teachers.

[9] Follow-up studies by Hanushek reach similar conclusions about the effects of these teacher variables. As an example, in Hanushek's 1989 review, teachers' advanced degrees predicted higher levels of student achievement in only 13 of the 183 studies reviewed, and there was a *negative* relationship in 6 of the 13 studies.

[10] The term "certification" is generally used interchangeably with licensure.

[11] Related to the issue of licensure is the question of the relationship between teacher performance on licensure exams and student achievement. Several studies do show a positive association between the two. Ferguson (1991) found that in the aggregate, the average performance of districts' teachers on the state's teacher certification exam had a strong positive effect on the average student achievement levels in the district. Strauss and Sawyer (1986) found similar results of student achievement with regard to teacher performance on the National Teacher Exam.

[12] Emergency certification can be issued to teachers who have not satisfied all of the requirements necessary to obtain a standard certificate.

[13] For example, Darling-Hammond (2001) wrote that the Abell report "dismissed or misreported much of the existing evidence in order to argue that teacher education makes no difference to teacher performance or student learning, and that students would be better off without state efforts to regulate entry into teaching or to provide supports for teachers' learning" (p. 60). A rejoinder by the Abell Foundation to Darling-Hammond refutes this assertion.

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[14] For example, some studies found that students of alternatively certified teachers do at least as well as students whose teachers are fully state certified (Barnes, Salmon, & Wale, 1989; Goeble, Romancher, & Sanchez, 1989; Miller, McKenna, & McKenna, 1996), while others (e.g., Hawk, Coble, & Swanson, 1985) found that that fully licensed teachers are more effective.

[15] Some have theorized there is a U-shaped relationship between teacher experience and student achievement, and that at some point the negative effects of teacher inexperience wears off relative to the negative effects of excess teacher experience and age (Kain, 1995; Kain & Singleton, 1996).

[16] The increased failure rate may be partially due to changes in the actual test, however.

[17] Based on information from the *Baccalaureate and Beyond* survey, a national sample of individuals graduating from college in 1992-3, 13.39 percent of public school teachers had master's degrees whereas only 10.68 percent of non-teachers have master's degrees (Goldhaber & Liu, 2003).

[18] Furthermore, even if there were little relationship between academic proficiency and teacher quality, one would need to posit a negative relationship between the two in order to reach the conclusion that the teacher labor market was not losing many high quality teachers.

[19] For example, in a recent Associated Press article explaining New York City's plan to phase out uncertified teachers, Education Commissioner Richard Mills explained that "children in the lowest performing schools can, *should* and will get certified teachers," implying that uncertified teachers were a second-rate educational resource (quoted in *Teacher Quality Bulletin*, 2000).

[20] For example, in 1998 the pedagogical training requirement varied from six semester units in Texas to 36 in some states (Feistritzer & Chester, 1998).

[21] Although we might imagine the effect to be small, the lack of portability of the teaching credential might in fact deter some prospective teachers from pursuing a career in the teaching profession.

[22] These calculations are based on 1999 figures from NCES *Digest of Education Statistics* (U.S. Department of Education, 2000) and the *AFT 1999 Salary Survey* (American Federation of Teachers, 1999). Teachers salaries were annualized and compared to salaries of other professionals. Using the percent increase between teachers salaries and other professionals' salaries, an annual total in education spending was derived. That total was divided by the number of students in order to estimate per pupil costs.

[23] For example, in 1987-88, 1990-91, and 1993-94, over 80 percent of public school districts required that teachers have full standard licensure in the field they taught (U.S. Department of Education, 1997).

Appendix: A Primer on Statistical Methods

Methodology

The academic achievement of students is influenced by a number of factors: innate abilities may predispose students to achieve in particular subject areas, family situations and home environments can either cultivate or discourage learning, and neighborhood and peer influences may foster or dissuade students. All these factors are outside the direct control of educators; thus, when assessing the impact of various education factors on an outcome like student achievement, researchers attempt to use methodologies that isolate the effects of school-specific factors from personal, family, or other influences on student achievement.

Regression analysis, which uses statistical models to make predictions about outcomes, is the typical statistical tool that researchers use to estimate relationships between education factors and student achievement or other dependent variables.[1] A key feature of regression analysis is that the regression will accurately establish the relationship between dependent and independent variables if the model is correctly constructed. In particular, it is possible to determine the relationship between each independent variable and the dependent variable by holding constant the influence of the other independent variables, a condition referred to as *ceteris paribus*.[2]

The most commonly used model in education studies is referred to as the "educational production function," which dates back to the *Equality of Educational Opportunity* report in 1966 (also known as the Coleman Report).[3] Using this model, it is possible to assess how school factors, such as class size, teachers' degree level, types of teacher licensure, or years of teaching experience, influence student achievement while other factors, such as family income, are held constant. It is an important way to isolate the impact of school factors on student outcomes from other influences.

Data Factors and Conclusions

While regression analysis allows researchers to examine the *strength of the relationship* between independent and dependent variables, a regression may not always accurately identify

the *nature of the relationship* between the two variables, specifically if the relationship is correlational or causal.[4] In general, having better, more detailed data allows researchers to utilize more sophisticated statistical models and perform tests that permit them to be more confident about the nature of relationships—that is, whether they are causal or not.[5] A key feature of data that allows researchers to better assess relationships and sort out issues of causality is the degree to which the variables in the dataset and in statistical models are measured accurately. Unfortunately, virtually all datasets have variables that are mismeasured to some degree. For example, studies often determine a student's class size by dividing the total number of students in the school by the total number of teachers (or professionals) in the school. But clearly not every student has the same size classroom and not every professional in the school has a classroom or the same number of students. Thus, in this example, the variation in class size *within* schools means that we may not have properly characterized the true class size for a particular student or group of students.

It is important to understand that some variables serve as proxies for others. As an example, teachers who have advanced degrees may be more effective in producing growth in student achievement. Clearly, however, the degree itself does not cause them to be more effective; rather the degree may be a proxy for their knowledge of appropriate teaching practices or their knowledge content. If researchers know what a variable, like degree level, represents, they can infer policy implications from findings. The danger is that mistakes are made about what certain variables actually represent, leading to misjudgments about the implications of various interventions.

As a purely hypothetical example, assume that teacher motivation is positively correlated with both student achievement and an advanced degree. If researchers do not account for motivation in the model, the relationship between teacher degree levels and student achievement might suggest that increased student achievement results from teachers having an advanced degree when in fact the cause is actually teacher motivation. Policy-makers might infer that the knowledge gained through degree programs helped make teachers more effective and, therefore, require them to obtain advanced degrees. If, however, it is motivation that leads to both teachers earning advanced degrees and increased student achievement, we would not anticipate the advanced degree requirement to necessarily increase student achievement, since the requirement itself would not change the underlying important variable: teacher motivation.

Careful use and measurement of data as well as model design help researchers design studies that explore not only the size of the relationship but also the nature of the relationship. One methodology that is key to understanding the contribution of schooling factors to student achievement is the examination of achievement *growth* rather than achievement *levels*.[6] Measuring *growth* in student achievement over a specified period of time, rather than achievement level at a single point in time, is generally a more accurate way to understand the effect of certain education factors on student achievement. Thus, when referring to student achievement, we are referring to *value-added* measures of student achievement growth, i.e., the contribution of various factors toward growth in student achievement. Although test scores are not the only, or necessarily the best, measure of what students have learned, they are commonly used to assess achievement since they provide easily quantifiable benchmarks of students' progress. Thus, unless otherwise noted, our references to studies or findings about student achievement refer to achievement on some type of paper and pencil exam.

What does all this mean for measuring teacher quality? It means that understanding relationships between independent teacher variables and student outcomes is complex. It is not uncommon for studies to misunderstand the nature of the relationships. Thus, it is appropriate to look for broad patterns of results from a variety of different studies when investigating the impact of teachers and the correlates of teacher quality. Throughout this monograph, we have explored and tried to summarize the various findings from studies conducted on the relationship between specific teacher characteristics and student outcomes in order to gain some understanding of what teacher factors positively influence student learning.

Notes

[1] Experimental studies, where individuals are randomly assigned to either a treatment or control group, represent the most rigorous research design for controlling for the direction of causality and unobservables. For many reasons, however, educational experiments are rare. Regression methodologies usually represent the next best option to assess the impact of educational resources on students.

[2] In practice, many of these variables cannot so easily be held constant. It is rare, for instance, to see students from very affluent families in schools with low per pupil spending because affluent families tend to live in areas that support high levels of school spending. Still, regression analysis is a useful framework for public policy purposes because policy-makers need to have a sense of how different educational investments are likely to affect students.

[3] This formulation of the relationship between the dependent and independent variables calls for identifying the *maximum* possible level of output from each conceivable combination of inputs. It is a significant stipulation and makes it possible to derive causal inferences from a true production function. The educational production function framework is certainly a simplification of reality, and the notion that it can be used to assess the effects of educational resources on students does not go unchallenged (Monk, 1992). For a discussion of this methodology, see Hanushek (1979) and Brewer and Goldhaber (1996).

[4] As an example of the distinction between a correlational and causal relationship, imagine a dog and its owner regularly walk along a beach in the sunshine and both develop skin cancer. A person who observed many owners and their pets living near the beach might infer that cancer is transmissible from dogs to humans and *vice versa*, rather than identifying the true impact of the sun on both dogs and humans.

[5] The distinction between a causal and correlational relationship is illustrated by Mayer (1997), whose study suggests that the strong relationship between high parental income and student achievement is not because being raised in a family with higher income will lead to better students. Rather, parents who tend to earn higher incomes also tend to have other traits or practices that are conducive to their children's learning.

[6] Thus, if the dependent variable of interest is student achievement, measured, for instance, by performance on standardized test scores, datasets should have student achievement information from least two different points in time so that it can be determined how much a student learned over a defined period of time, measured as the difference between the first or "baseline" achievement score on a standardized test to the later and second score on that standardized test.

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